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**Publication bias in a recent meta-analysis on breastfeeding and IQ**

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Horta et al. (1) assembled a meta-analytic dataset on an important question: the effect of breastfeeding on children's cognitive test scores. Using a rigorous set of inclusion criteria to screen out poor-quality studies (e.g. those that had no comparison group; those that did not use standard cognitive tests), they estimated that children in the groups who were breastfed had on average a 3.44-point higher IQ score. Their meta-analysis was cited prominently in a recent *Lancet* review on the effects of breastfeeding (2).

Unfortunately, Horta et al.'s discussion of publication bias was suboptimal. They state that they used funnel plots and Egger's test to assess this bias, but did not report the results from these methods. Instead, they arbitrarily stratified the studies by sample size and concluded that, since the effect sizes were similar in studies with greater than and less than 500 participants, publication bias was not a concern. Having run a number of additional publication bias tests on their dataset, I disagree with Horta et al.'s conclusion on this issue.

The (contour-enhanced) funnel plot of Horta et al.'s dataset is shown in Figure 1. It indicates a strong tendency for more precise (larger) studies to find smaller effects, and is thus suggestive of publication bias. Egger's test for funnel plot asymmetry was significant ( $t(16) = 3.29, p = .005$ ), as was the mixed-effects variant of this test ( $z = 2.98, p = .003$ ).

--Insert Figure 1 here--

A trim-and-fill analysis added eight additional studies to produce funnel plot symmetry, and indicated a smaller (but still significant) overall effect of breastfeeding (1.38 IQ points, 95%CI = [0.16, 3.92],  $z = 2.21, p = .03$ ). A Precision Effect Test-Precision Effect Estimate with Standard Error (PET-PEESE) analysis (3) produced a small, non-significant effect for its PET estimate (0.21 IQ points, SE = 0.57,  $p = .71$ ), and a reduced but still significant effect for its PEESE estimate (1.20 IQ points, SE = 0.45,  $p = .02$ ).

Note that these analyses do not necessarily show a null effect of breastfeeding on IQ. Indeed, a  $p$ -curve analysis (4) indicated that the dataset shows evidential value (binomial test  $p = .002$ ; full  $p$ -curve  $z = -8.84, p < .001$ ; half  $p$ -curve  $z = -8.02, p < .001$ ). However, the above tests suggest that the meta-analytic effect size might have been overestimated.

With only eighteen high-quality studies in the meta-analysis, it is premature to draw any strong conclusion at present about the effect of breastfeeding on IQ. However, given that the very highest-quality studies (those that met all of Horta et al.'s criteria and also adjusted for maternal IQ) showed an even smaller effect than the potentially-overestimated one in their main analysis, it is right to be sceptical of claims that breastfeeding has a substantial impact on children's cognitive abilities. Ultimately, large, pre-registered experimental studies—not meta-analyses of observational research—will be required to resolve this question.

### References

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Figure

Figure 1. Contour-enhanced funnel plot of the breastfeeding-IQ meta-analysis. The white area of the plot includes effects where  $p > .10$ , the light-grey shaded contour area includes effects where  $.05 < p < .10$ , the darker grey shaded area includes effects where  $.01 < p < .05$ , and the remainder of the plot includes effects where  $p < .01$ .

